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ABSTRACT

This paper describes the use of the CoFIND (Collaborative Filter in N Dimensions) system to evaluate two assessment styles. CoFIND is a resource database that organizes itself around its users' needs. Learners enter resources, categorize, then rate them using "qualities," aspects of resources which learners find worthwhile, the n dimensions of CoFIND. Categories and qualities are created by CoFIND's users, so the system sculpts itself to a group's expressed needs. This paper contrasts two uses of CoFIND where students added and rated their own Web-based assignments. The first of these provided useful material to help the students with further learning goals, while the second let them use skills they had acquired in a concrete setting. The use of qualities in each instance was very different, reflecting the students' different needs in each case. Based on the results, suggestions are made for how virtual ecologies of self-organizing groups of learners might be encouraged to thrive and grow. (Contains 19 references.) (Author)

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Evaluating assessment using n-dimensional filtering

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Abstract

This paper describes the use of the CoFIND (Collaborative Filter in N Dimensions) system to evaluate two assessment styles. CoFIND is a resource database which organises itself around its users' needs. Learners enter resources, categorise, then rate them using "qualities," aspects of resources which learners find worthwhile, the n dimensions of CoFIND. Categories and qualities are created by CoFIND's users, so the system sculpts itself to a group's expressed needs.

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Based on our results we suggest how virtual ecologies of self-organising groups of learners might be encouraged to thrive and grow.

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Introduction

This paper describes an unusual approach to the evaluation of the effectiveness of assessed coursework provided for a group of graduate students at the University of Brighton, UK. It makes use of metadata exposed and created by the students to discover common values and attitudes to the work that they are required to perform. These metadata are the product of a Web-based system known as CoFIND (Collaborative Filter in N Dimensions).

About CoFIND

CoFIND has been described elsewhere and we present a relatively brief description of it here by way of foundation. The main focus of this paper is to examine the different kinds of metadata generated by the students and to draw some conclusions about how this relates to their perceptions of and attitude towards assessment tasks.

CoFIND is a self-organising resource database for learners. Resources (usually in the form of URLs, although the system can also take free text entries describing any object or which are themselves resources) are entered into the system by learners, who may have created the resource or have found it useful and wish to share it. Learners are encouraged to classify resources using existing classifications (following conventional usage we describe these as *topics*) or new ones which they enter themselves, collaboratively giving the system a functionality not dissimilar to that of a Web directory such as Yahoo or Newhoo.

One of CoFIND's unique features is its use of a form of metadata which we characterise as *qualities*. Qualities are those aspects of resources which learners consider important when choosing to use them. They are thus statements of value about a resource and might typically consist of words and phrases like *good for beginners*, *funny*, *comprehensive*, or *simple*. Qualities are used to give ratings to resources which provide potentially richer and subtler indications of the value of a resource than those of other collaborative rating systems or collaborative filtering engines such as NetPerceptions (www.netperceptions.com), DBLens (dblens.sourceforge.net), or MatchPoint (www.triplehop.com). Qualities are the n dimensions of CoFIND, providing a multi-faceted collaborative view of the system relevant to and generated by its users.

Through a combination of metrics based on the way that users interact with the system which include ratings, usage, and the frequency with the system is used, CoFIND arranges the presentation of topics, qualities and resources dynamically. It is designed to respond to individual local interactions such as rating a resource or selecting a quality to produce a self-organised system without a central designer.

CoFIND has been put to a range of different uses, including helping learners to find appropriate Web-based resources for their learning needs (Dron et al. 1999; Dron et al. 2000b; Dron et al. 2000a; Dron, Boyne & Mitchell 2001) and collaboratively discovering what makes a website good (Dron et al. 2000c). The studies discussed in this paper describe the use of CoFIND to enrich the process of student assessment, a side-effect of which is to allow us to find out some useful information about how students perceive the work that they are asked to perform.

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A learning ecology

CoFIND's qualities are used to rate and discover resources which are not only appropriately classified as belonging to a particular topic but which fulfil specified needs described by the qualities. Resources classified as belonging to a particular topic are returned in a list ordered by their ratings for a selected quality. As ratings are given to resources, so their position in the list for that particular combination of topic and quality changes.

Learners may add new qualities if those which are already available do not seem appropriate to their needs. Unfortunately, a newly added quality will not have been used to rate any resources and so will be of little use in retrieving useful lists of resources. This could lead to a vicious circle, an example of the cold start phenomenon which affects most collaborative filtering systems (Harney 2000). The phenomenon occurs because the system only becomes useful once sufficient ratings have been given, but ratings are only given if the system is used, which is unlikely because there are insufficient ratings to make it useful. To help overcome this, when adding new qualities learners may allow them to inherit ratings from one which already exists. For example, a user adding the quality "simple" may allow it to inherit votes from "good for beginners." Like much of what underlies CoFIND, this borrows heavily from mechanisms which drive evolution in natural systems.

Qualities are presented as a list of hyperlinks, potentially in various different font sizes, dynamically ordered. Figure 1 shows one such list.

The size of each quality is proportional to the number of times the quality has been used to rate resources within the selected topic, compared with other qualities. Larger quality labels imply that more useful results will be found if the learner follows those links. The order of qualities in the list is partly determined by use (qualities which are most frequently selected), partly by votes cast using those qualities to rate resources within the selected topic, and partly by a weighting based mainly on the age of the quality. To cater for a potentially large number of qualities of low value to other learners, qualities may "die," dropping off the list entirely. This prevents inappropriate qualities from retaining a foothold in CoFIND's ecology. Qualities of little use get smaller, drop down the list and eventually disappear. Again, this process is inspired by natural evolutionary processes.

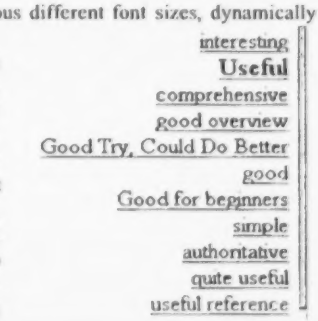

Figure 1 – competing qualities

Stigmergy

The use of varying font sizes and dynamic ordering of the list returned is designed to make use of a positive feedback mechanism found widely in natural and human systems known as *stigmergy*, a kind of indirect communication via the environment (Heylighen 1999). Examples include the formation of ant trails, the construction of termite mounds or the emergence of forest footpaths. In stigmergic systems, each individual's actions affect its environment which in turn influences the actions of others. For example, ants returning to a nest with food leave a trail of pheremones. Ants which otherwise wander relatively aimlessly are more likely to follow a trail of pheremones. The stronger the trail, the greater the likelihood that others will follow it. As more ants return with food, the trail gets stronger. When the food eventually runs out, the scent dissipates and the trail vanishes. Within CoFIND, learners are more likely to select qualities in a larger font and/or higher up the list. Likewise, because learners are more likely to visit resources which are highly rated, they are more likely to provided ratings for resources which have already been rated, which (if the resources are considered worthwhile) means that the position of qualities on the list and their size is further enhanced.

Self-organisation

Without constraint, stigmergy could lead to what complexity theorists describe as a Stalinist regime (Kauffman 1995), a system locked into a fixed pattern of behaviour where novelty has no chance to take hold. We would equally wish to avoid what the same complexity theorists call a Red Queen Regime, where change is so frequent that no stability is ever reached and the system descends into chaos. CoFIND's algorithms are tuned to create a dynamic system balanced at the edge of chaos, with sufficient stability to create structure but with sufficient adaptability to cater for learners' changing needs. Driven by the positive forces of learners' needs and stigmergy, evolutionary forces act on the

results, constraining growth through the survival of the fittest. This can result in a self-organised learning ecology of potentially high complexity and variegation, with different species of quality fitting different ecological niches which relate to the different and contextually situated needs of learners. Through their combined individual interactions, a clear structure to the available resources emerges without the intercession of a t eacher or instructional designer.

The use of topics in the studies which this paper describes was intentionally constrained so we will not discuss the mechanism in detail here. In normal use topics are generated by students and are self-organised using a stigmergy and evolutionary processes to help to provide a guided path through a subject area. We have discussed this elsewhere (Dron et al. 2000a; Dron, Boyne & Mitchell 2001)

Through the use of qualities, CoFIND provides a unique glimpse of a group of learners' view of what is important in a learning resource. It becomes a mirror of the needs, aspirations and motivation of the learners who use it, whatever those needs may be. It is this aspect of the system which we make use of in the following studies.

Using CoFIND- two example case studies

Description of the case studies

Both of these studies involved the same group of 35 students studying for an intensive one-year conversion Masters degree in Information Systems. All of the students had previous degrees in subjects unrelated to Information Systems. The intensity of the course and its group-orientated ethos typically results in a very close-knit community of highly motivated individuals.

Both studies presented here relate to a stream of the course which teaches networking and Internet technologies, from low-end protocols through to Web application building. The networking and Internet technologies stream straddles two semesters. At the end of each semester is a traditional unseen examination preceded by a two-week personal assignment. These studies primarily look at the use of CoFIND as a support and evaluation mechanism for the work produced in these personal assignments.

The first assignment

The first assignment given at the end of the first semester required students to produce Web pages written using XHTML to provide tutorials on technologies related to the module. The students were allowed to choose any network-related topic which interested them, including but not limited to any topic taught on the stream. For some, this provided an opportunity to revise or clarify work already covered, which was therefore of interest to the entire cohort and would be perceived as useful preparation for the examination they were shortly to sit. For others, it was an opportunity to explore areas on which they were writing a 12,000 word dissertation due in the second semester. All students selected a topic related to one of these two functions. Given the intensive nature of the course this is to be expected, as the students needed to make the best use of the time available to achieve their main goal of gaining an MSc and did not wish to investigate a topic out of simple curiosity.

At the end of the assignment, the students were required to add references to their pages to CoFIND. They were also required to look at and rate at least three of their colleagues' tutorials, with a small penalty (a total of three percent of the marks) being applied to those who failed to do so. There was no need to implement this penalty, as all students rated more than three sites. Following discussions with the course leader it was decided that the students' own assessments of each other should not contribute to the formal mark received.

The students were already familiar with CoFIND as since the start of the stream it had acted as a resource base providing references which both they and the tutor had found and rated. It is significant that although the system had been used by all students leading to a database of nearly one hundred relevant rated resources, the level of activity and especially rating had not been very high, averaging around 10 ratings per week over the course of the semester.

The second assignment

The second assignment given at the end of the second semester required students to produce a Web-based application implementing some of the functionality of a system which they had already been analysing, designing and programming for other streams of the course, based on a rich case study designed to give a moderately authentic experience of working on an IT project. Crucially, the assignment was therefore perceived as an activity giving summary evidence of the skills which they

had been learning during the latter half of the stream. The assignment was based on a fictitious company called *Stowaways* offering holidays on the rivers and canals of England.
Like the first assignment, students were required to enter links to their work into the CoFIND system with the threat of marks being deducted from students for failing to rate at least two of their colleagues' sites. Like the first assignment, there was no need to apply this penalty, although most students *only* rated two sites. Again, the course leader advised against allowing the students' own assessments to contribute to their formal mark for the module.

Results

Over three times as many ratings were given for the first assignment as for the second (288 for the first, 88 for the second). This did not seem to be unduly affected by other factors such as learning or boredom as, apart from during the period of the assignments and troughs during vacation periods, use of the system for sharing resources remained consistent throughout both semesters.

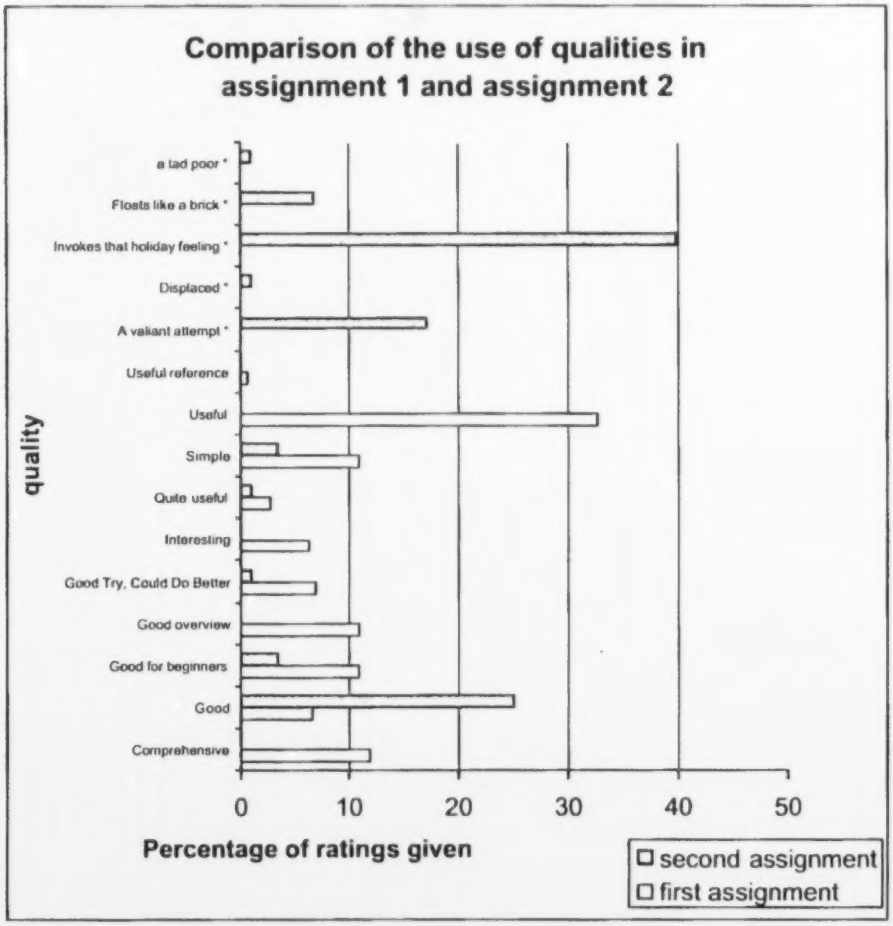

Figure 2 – comparison of use of qualities for the two assignments

As may be seen from figure 2, there is very little similarity between the use of qualities in the two assignments. Although new qualities were available and were added during the second assignment, all of the existing qualities used in the first assignment had survived the evolutionary process and were still available for the students to use. A closer look reveals that, in order of popularity, the top five qualities for the first assignment were *Useful*, *Comprehensive*, *Simple*, *Good for beginners*, *Good overview*. Three of these (including the top two) were not used at all for rating work supplied for the second assignment, and even those that were (*Good for beginners* and *Simple*) achieved less than five

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percent of the votes cast. By contrast, the top five qualities for the second (*Stowaways*) assignment were *Invokes that holiday feeling, Good, A valiant attempt, Floats like a brick , Good for beginners* and *Simple* (joint fifth place). Both assignments showed the traditional bell-curve in grades achieved, without any clear difference in the distribution of marks.

Discussion

Qualities as aids to learning

The qualities used by the students for the first assignment are broadly those that would be helpful in finding resources from which to learn and to revise for exams. They are the sort words which a teacher might use to describe resources from which a student might learn, whether explicitly or implicitly. If a teacher suggests that students read a particular resource it is by definition because he or she feels that the students would find it useful (the most popular quality for the first assignment). The teacher might then go on to explain why it is useful (for instance, it gives a comprehensive view of the subject, it is simple, good for beginners or it gives a good overview) which would help to match that resource to the needs of a particular student or group of students. One of the charms of the CoFIND system is that the students themselves are likely to have a better idea of how particular resources match their own needs than the teacher, at least when averaged, and the use of qualities in the first assignment seems to be a clear an expression of those needs.

By contrast, with the exception of the last two qualities in joint fifth place, there is nothing in the qualities for the second assignment which suggests any value at all as a learning resource. Instead, the qualities used are variants on the single dimension of good to not-good which is used in virtually all collaborative rating systems on the Web. In fact, interviews with students indicate that the last two qualities are not exceptions at all, but were supplied by the overly modest students who added the resources themselves, not as a description of their educational value but as a way of drawing attention to their inadequacy. Given that the second assignment was based around holidays on waterways the fact that two of the most popular qualities were humorous variations on the theme is noteworthy, again giving clear evidence that the students were not concerned with the outcome of their voting, merely that it was seen to be done.

Term ambiguity

Term ambiguity of the sort seen in the differing uses of *good for beginners* and *simple* is a difficult problem which affects any classification system (Lakoff 1987). It is primarily for this reason that CoFIND has been targeted squarely at small, tightly focussed cohorts of learners with clear and well defined needs, on the assumption that they would in general share a vocabulary and world view. As this study shows, even within such a constrained environment such world views are dynamic and transient things, shifting with the needs of the learners. Learning changes people and the qualities which they choose to assess learning resources provide a clear indication of this. How this affects the way that learners later perceive resources rated using an earlier world view has yet to be shown, but will make an interesting subject for further study.

Frequency of rating

The relevance to the students of the output of the two assignments is clearly demonstrated in the number of ratings given in each instance. The fact that the results of the second assignment were of no apparent further use resulted in the minimum of ratings being given, driven almost entirely by the extrinsic motivation of not wanting to lose any marks, but without the intrinsic motivation provided by the first assignment of wanting to help to build a collaborative resource of further use to the learning needs of the cohort.

Justifications for assessment are often given on the grounds that they help to provide focus and motivation for students, as well as providing a basis for much of the formative process essential to learning (Bruner 1966; Gagne 1985). They are also an interface between examining institutions and the outside world, giving an indication of a student's worth to potential future employers. However, at the same time they are often obstacles to learning, parts of a system which feeds on itself at the expense of the needs of its users, whose primary motivation we would wish to be to learn, rather than to achieve a qualification (Whitehead 1929; Illich 1971; Holt 1977) Our findings provide some evidence that, when used purely as an extrinsic motivator, assessments are far less significant to the students than when those assessments contribute directly to that learning process. This is entirely in keeping with the

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model of engaged learning proposed by Jones et al (1995) who state firmly that assessment should involve a performance or demonstration, usually for a real audience and useful purpose, as well as having meaning and purpose for the learner. In this case there is a second layer of indirection at work, inasmuch as from the students' perspective the most useful function served by the results of the assessed task in the first assessment was to feed the their needs in addressing a further assessment (the end-of -semester examination).

Possibilities

We can imagine a scenario where CoFIND might be used to collaboratively generate an entire course in higher education. The course could be constructed from a set of assessments, each building on the last, each leading to collaboratively generated further knowledge with direct relevance to the next task. More controversially, It is possible that such a system might be formed without the direct intercession of a teacher in the design process. If students were to be given sufficient resources (including static materials, reactive support from subject experts and suitable infrastructure for communication) and aimed very roughly in the right direction, the most highly rated student resources could provide the input for the next wave of assessment. A teacher or other arbiter (perhaps the students themselves) could take up the most popular themes, topics and areas and set them as the focus of another CoFIND-mediated investigation. The process would continue until the students felt that they had learned enough or an external arbiter (with full access to student work and opinions about it through CoFIND) considered that learning had been demonstrated. In this way a self-organised system of learning might be formed, with learning resources (being generated by the students themselves) naturally falling within Vygotsky's zones of proximal development (Vygotsky 1978). The approach would best be suited to a subject with a large body of knowledge mapped to a loose and flexible body of theory, as found in the medical and computing professions, where knowledge is achieved as a gestalt more than being assembled from sturdy foundations.

Conclusions

CoFIND is intended as a tool to aid collaborative learning, but it is clear from the example of these two small studies that in order for it to be effective it needs to be considered as part of a larger system. Simple application of technology is not enough to bring about useful collaboration, even where that technology is explicitly designed to replace some of the mediation role of traditional teaching.
CoFIND has shown itself to be a useful research tool which can form an image of the collective attitude of a group of students towards a body of work. In the studies we have looked at, CoFIND has helped to bring the attitudes of a group towards assessment tasks into sharp relief, demonstrating something we should have known already, that authentic tasks designed which have applicability to student needs are more likely to be useful to them than those which do not. Viewed from students' own perspectives, such needs may be quite different from those which we as teachers believe them to be. The second case study presented here was a well-intentioned and carefully designed integrated assignment providing what the teaching staff saw as an authentic grounding in the subject of study. However, the system of assessment and examination controls and determines the students' priorities and goals far more than the promise of some distant set of learning objectives (Dewey 1897) The success of the first assignment lies not in the success of the students in achieving the desired learning objectives but in its relevance to their immediate needs, consequently providing greater long term value than that of the second. With students benefiting from each other's work, gaining the benefits of "teachback" (Pask 1976) through explaining a subject to others all within a framework which reflects their own conceptions of what is of value in a learning resource, it is possible to conceive of systems incorporating tools like CoFIND, where the role of the teacher may dissolve further into the background as an instigator, a helper and a validator rather than a provider of knowledge.

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